

**NIST Technical Study**

# **Sofa Super Store Fire**

## **Draft Report for Public Comment**

Charleston, South Carolina  
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**National Institute of Standards and Technology**  
**U.S. Department of Commerce**

# **Sofa Super Store Fire Technical Study**

## **Objectives - Technical Study Team**

- 1) To determine why and how the fire spread so quickly**
- 2) To study conditions within structure, in terms of temperature, oxygen concentration, smoke movement, & tenability\***
- 3) To identify specific areas in model building and fire codes\*\*, standards and practices that warrant revision.**

\* Ability to escape unassisted

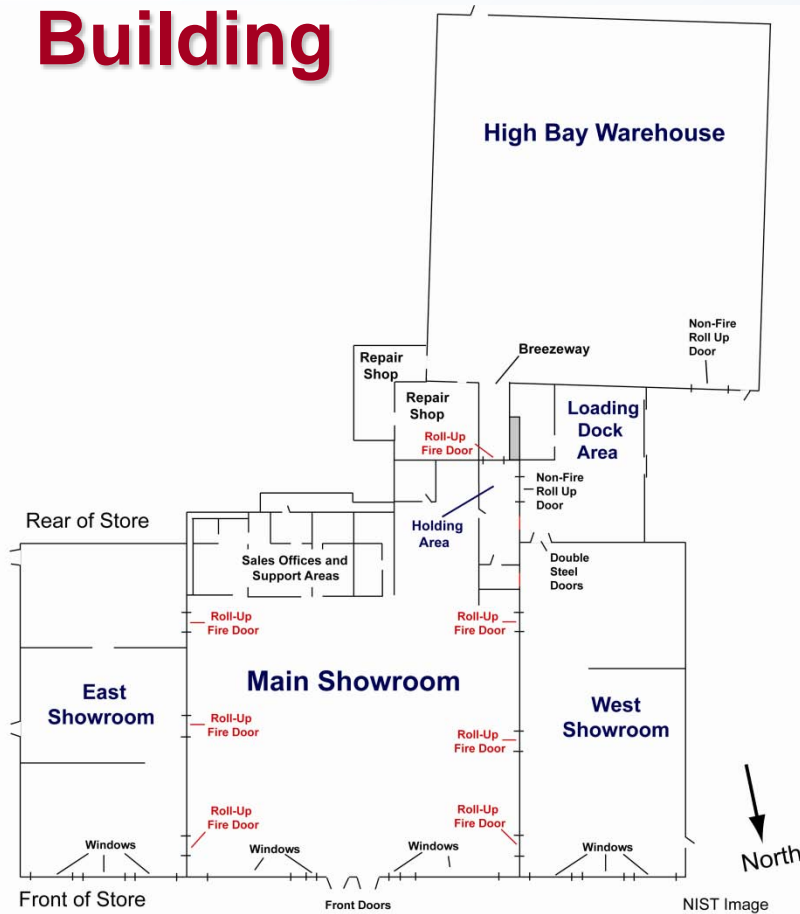
\*\*Codes used as national models for building and fire regulations. State and local jurisdictions have the option of incorporating some or all of model code provisions

# **Sofa Super Store Fire Technical Study**

## **Tasks-**

- 1) Identification of technical issues (why rapid fire spread) and major hypotheses requiring examination.**
- 2) Data collection - design records, video and photographic data, radio transmissions, field data, and interviews.**
- 3) Analysis and comparison of building and fire codes and practices, and review and analysis of practices used in operation of the building.**
- 4) Simulation and analysis of phenomena, including fire spread, smoke movement, tenability, and operation of active and passive fire protection systems.**

# Views of Building



(main entrance)

NIST Image



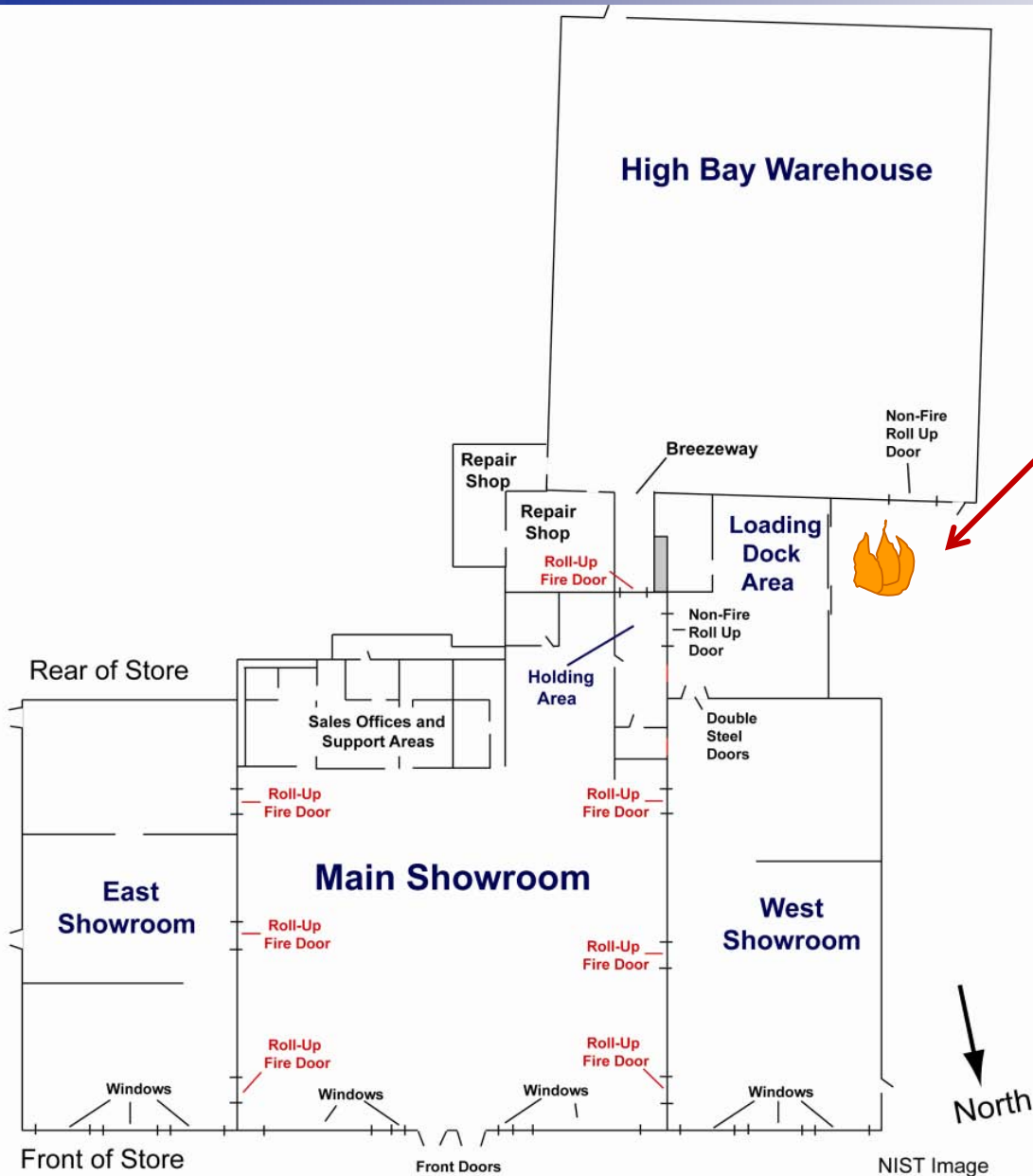
# Overall Time Line

<u>Time</u>	<u>Event</u>
6:56 pm	<ul style="list-style-type: none"><li>- Fire observed at rear of store</li><li>- store employee discharges port. fire extinguisher</li><li>- fire reported to 911 Center</li></ul>
7:08	<ul style="list-style-type: none"><li>- Dispatch receives report of fire behind store</li></ul>
7:09	<ul style="list-style-type: none"><li>- Engines 10 &amp; 11, Ladder 5, &amp; Battalion Chief dispatched</li></ul>
7:12	<ul style="list-style-type: none"><li>- Engines 10 &amp; 11, Ladder 5, Assistant &amp; Battalion Chief on scene</li></ul>
7:13	<ul style="list-style-type: none"><li>- Assistant Chief opens door and locates fire on loading dock</li><li>- Loading dock fully involved with fire</li><li>- Fire spreads to holding area and warehouse</li></ul>
7:16	<ul style="list-style-type: none"><li>- Fire Chief arrives on scene</li></ul>
7:20	<ul style="list-style-type: none"><li>- Engine 10 at loading dock receives water from Engine-12</li></ul>

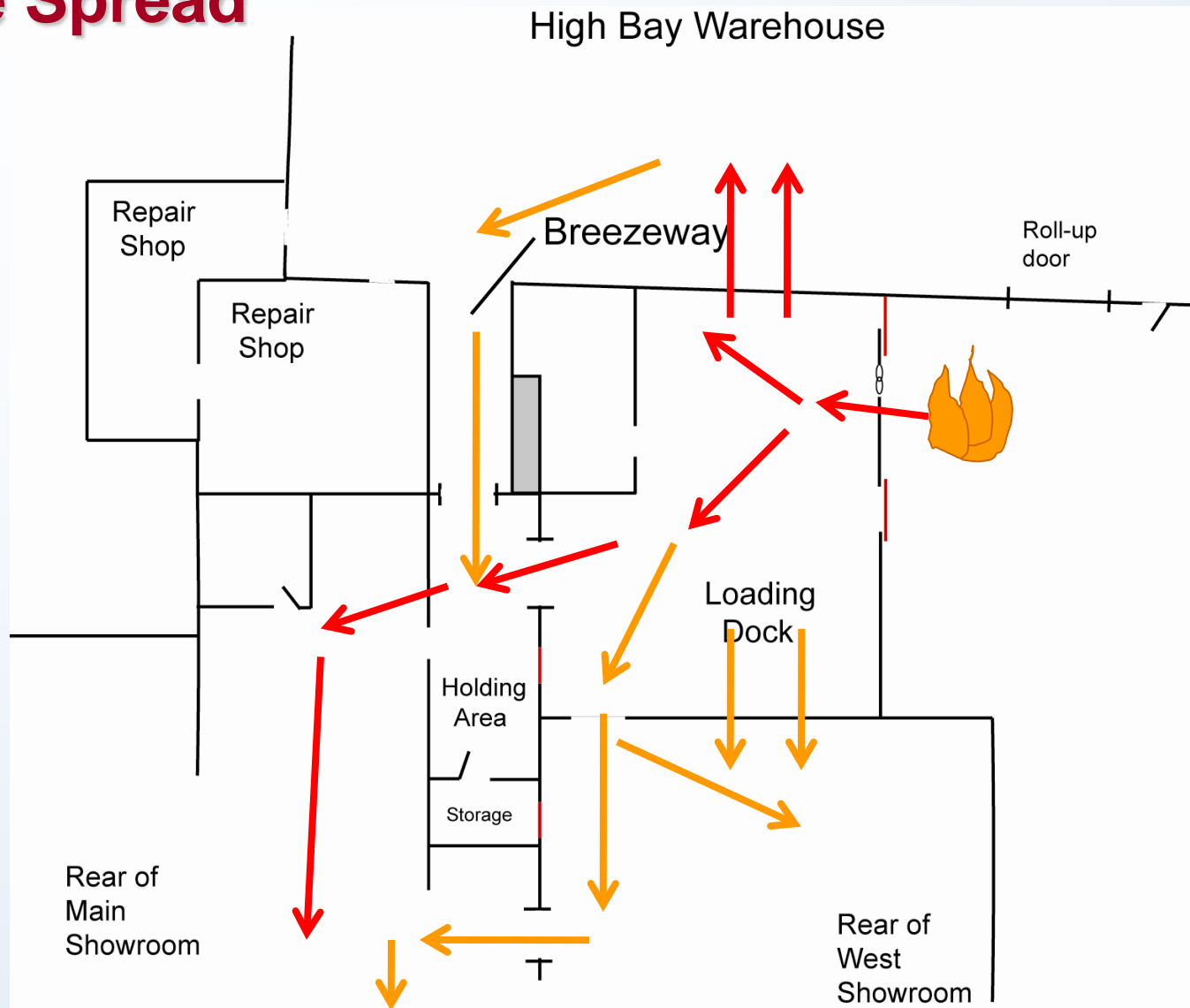
## Overall Timeline continued

<u>Time</u>	<u>Event</u>
7:27 pm	<ul style="list-style-type: none"><li>- Engine-11 at store front receives water from Engine-16</li><li>- Trapped employee calls 911</li><li>- “Lost or trapped inside “ radio call</li></ul>
7:31	<ul style="list-style-type: none"><li>- Employee rescued</li><li>- “Mayday”</li><li>- Fire Chief “....we need to evacuate building”</li><li>- Engine air horns sounded to evacuate building</li></ul>
7:35	<ul style="list-style-type: none"><li>- front windows vented</li><li>- brown smoke pours out of broken windows</li></ul>
7:36	<ul style="list-style-type: none"><li>- black smoke rolls out front windows</li></ul>
7:37	<ul style="list-style-type: none"><li>- fire rolls out front windows</li></ul>
7:51	<ul style="list-style-type: none"><li>- Portion of main showroom roof collapses</li></ul>
10:00	<ul style="list-style-type: none"><li>- Fire under control</li></ul>

## Fire Starts Outside Loading Dock



# Fire Spread



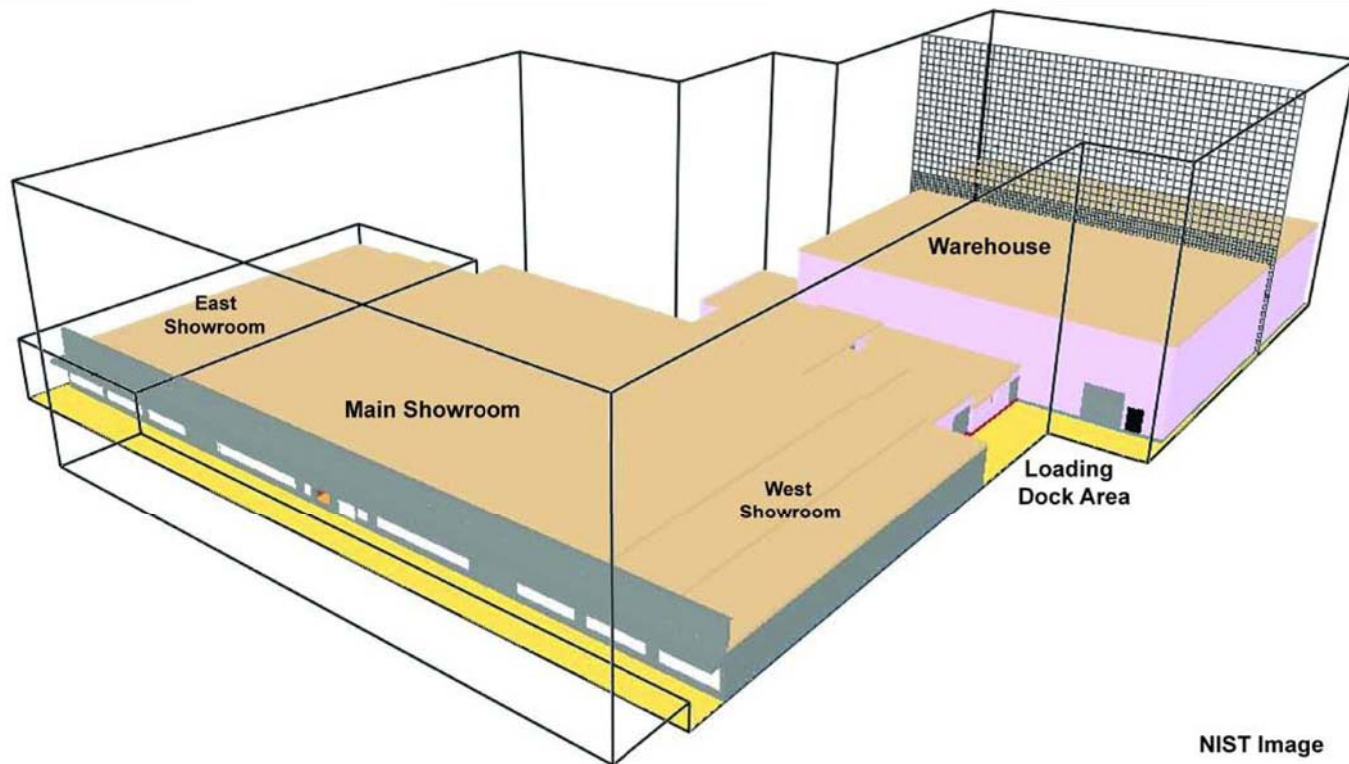
# Sofa Super Store Fire Technical Study

## Computer Simulation

- 1) Uses data on floor plan, materials of construction, opening of doors and windows, fuel load, weather, etc.
- 2) Each computer simulation requires about 4 days to run  
(required > 250 runs)
- 3) Compared simulation results to photographs, observations, interviews, and data. Most consistent simulation = most probable fire sequence
- 4) Multiple scenarios including impact of sprinklers, front windows intact, and roof openings
- 5) Output temperatures, oxygen concentrations, and smoke & flame within structure

# Sofa Super Store Fire Technical Study

## Computer Simulation – overall structure

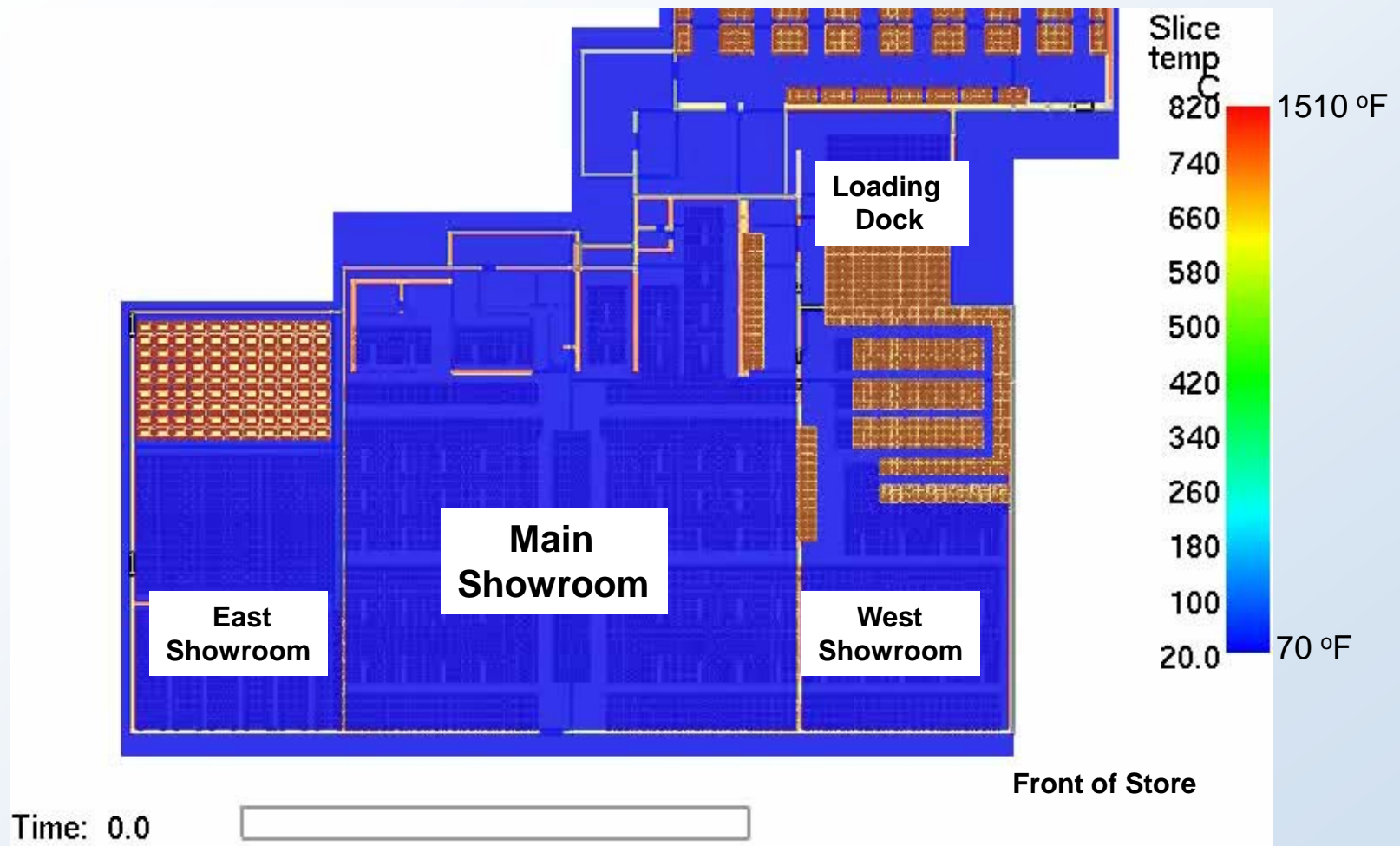


# Sofa Super Store Fire Technical Study

## Computer Simulation - Floor Plan with merchandise



# Temperature in the Sofa Super Store Computer Simulation

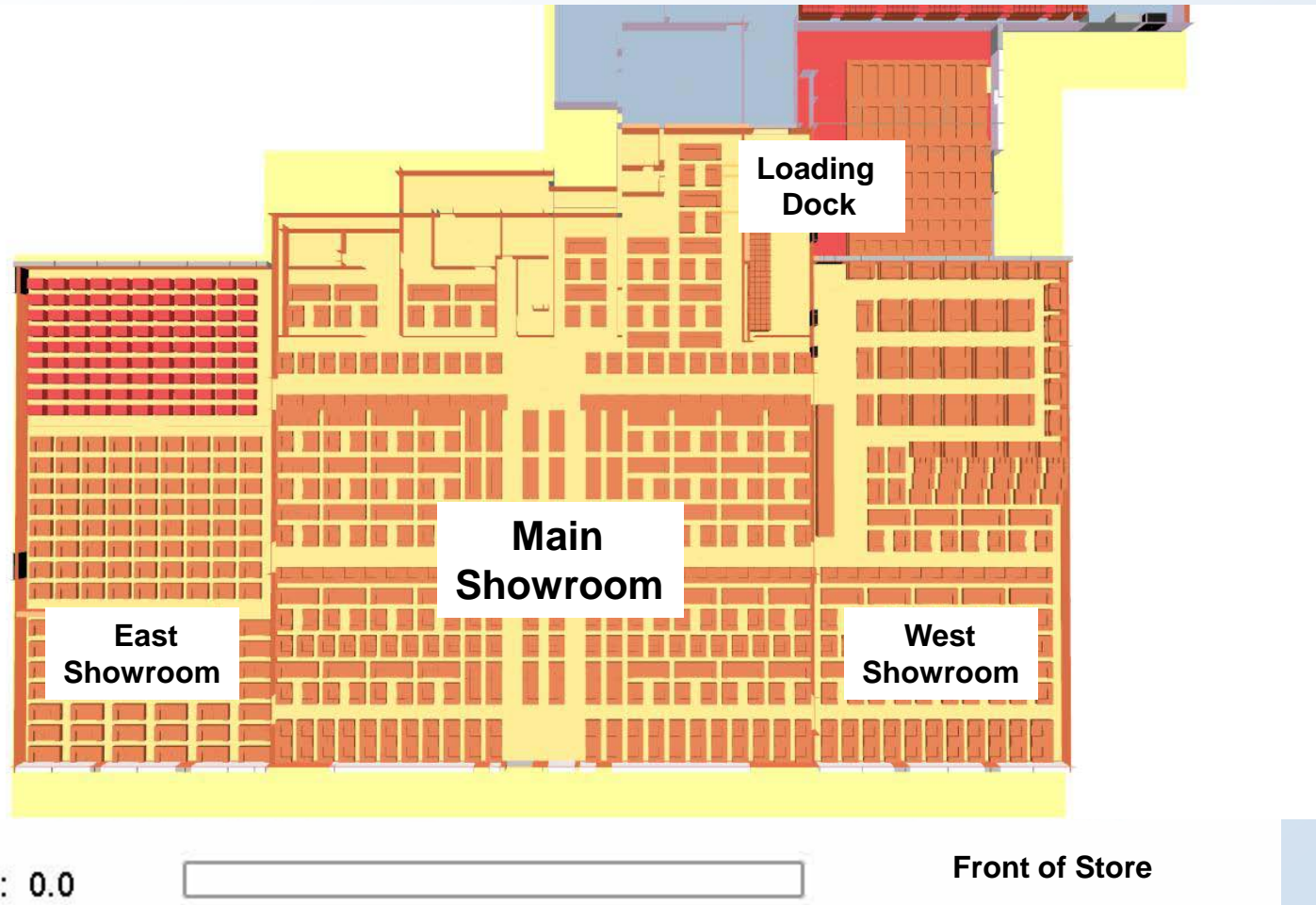


Temperature Slice - 5 ft above floor

20 x real time

# Smoke and Fire Spread in the Sofa Super Store

## Computer Simulation

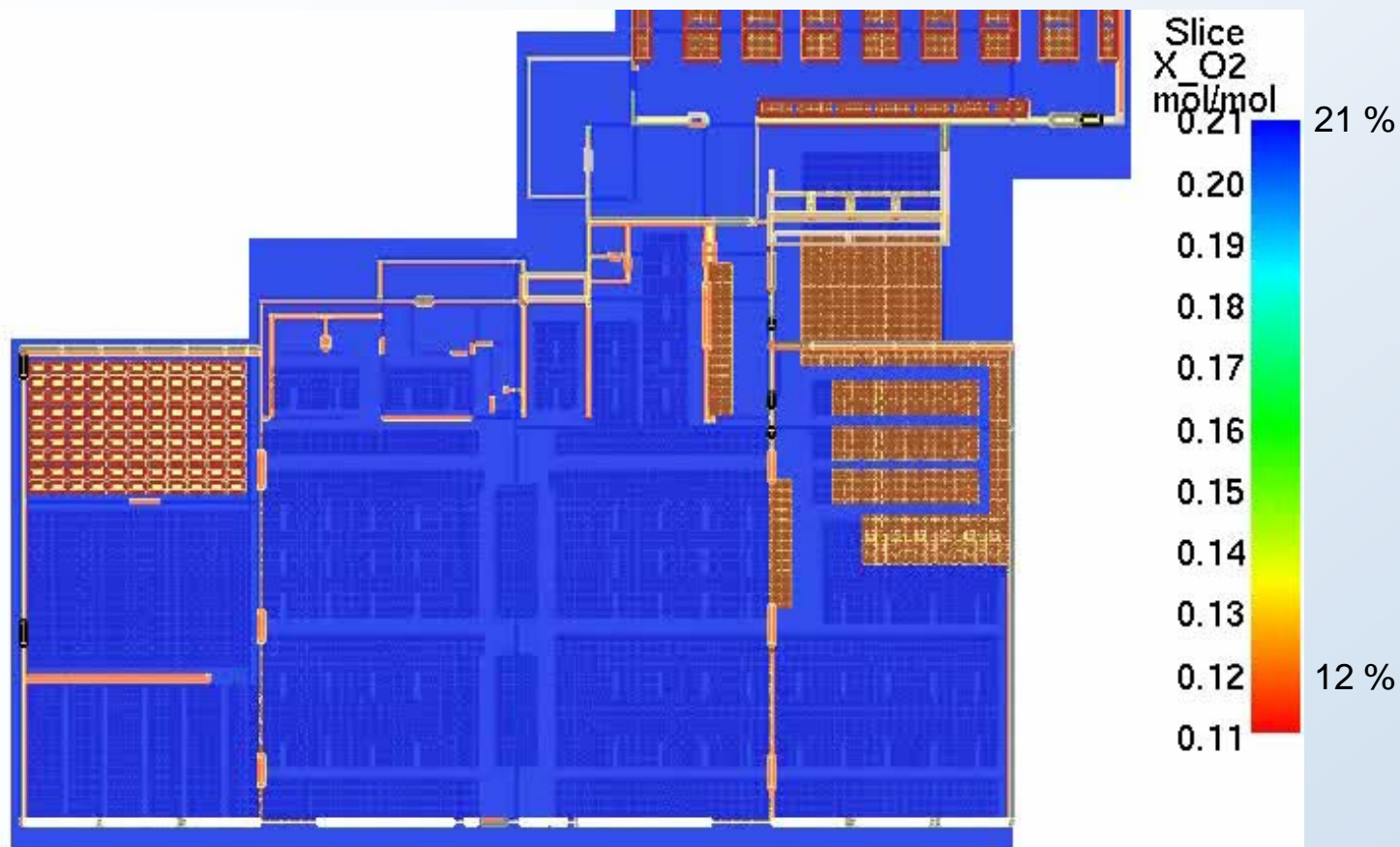


Smoke & Fire Slice Elevation - 5 ft above floor

20 x real time

# Oxygen in the Sofa Super Store

## Computer Simulation



Oxygen Elevation - 5 ft above floor

# Key Findings – Initial Conditions

1) Large amount of foam-filled furniture in showrooms (480 GJ), loading dock (130 GJ), and warehouse (840 GJ)\*

2) Large open areas

Showroom		Warehouse	Loading Dock
Main	17100 ft <sup>2</sup>	15800 ft <sup>2</sup>	2220 ft <sup>2</sup>
West	7020 ft <sup>2</sup>		
East	6940 ft <sup>2</sup>		

3) No automatic water sprinklers anywhere in store

\* 100 gallons of gasoline contains about 12 GJ of energy

# **Key Findings – Fire Spread into Showrooms**

- 1) Smoke and flames entered the holding area through the open roll-up door (non-fire activated).**
- 2) Fire spread was not visible from the main and west showroom during the early stages (5 to 10 minutes after fire department arrived).**
- 3) Smoke and flames flowed from the holding area into the space above the main showroom drop ceiling.**
- 4) Fire spread into rear of main showroom. Fire spread slowed by limited oxygen, ventilation limited.**
- 5) Layer of smoke and unburned fuel collected under ceiling in main and west showrooms; smoke filled floor to ceiling**

# **Key Findings – Fire Spread into Showrooms**

- 6) Fire began to slowly move towards front of store.**
- 7) Front windows broken out.**
- 8) Additional oxygen flowed in through broken windows and fire spread rapidly to front of main showroom (west side).**
- 9) Fire quickly spread across front of store, moved toward east showroom, into west showroom, and then rear of main showroom (east side).**

# Key Findings – Showroom Conditions

## Simulation time when conditions became untenable \*-

Time until Untenable Conditions		Temperature greater than 120 C or 250 F	Oxygen less than 0.12
<b>West Showroom -</b>			
	Front	23.3 min	26.6 min
	Rear	22.5 min	25 min
<b>West Main Showroom -</b>			
	Front	15 min	21 min
	Rear	15 min	21 min
<b>East Main Showroom -</b>			
	Front	22.5 min	23.3 min
	Rear	21 min	23.3 min

\* Ability to escape unassisted

# Non-Sprinklered and Sprinklered Simulations

No sprinklers were present in Sofa Super Store

## Computer Simulations

## Temperature Slice - 5 ft above floor



**Non-sprinklered**



**Sprinklers inside  
Loading Dock**

Sprinklers activate at  
50 seconds and 75 seconds

# **Key Findings – Fire Spread**

## **Sprinkler Scenario Simulation**

- 1) Sprinklers controlled fire on loading dock**
- 2) Sprinklers activated at 50 s and 75 s**
- 3) Conditions remained tenable throughout showrooms**

# Study Recommendations:

## **Furniture Stores represent unique fire hazards:**

- a) large quantities of foam-filled furniture
- b) large open space

1) NIST recommends: *All state and local jurisdictions should adopt model building and fire code covering new and existing high fuel-load mercantile occupancies.*

## **Hazardous conditions identified by routine inspections by skilled inspectors with appropriate follow –up**

- a) lack of sprinklers
- b) non-fire roll-up door
- c) wood framing of loading dock

2) NIST recommends: *All state and local jurisdictions implement aggressive fire inspection and enforcement programs and ensure that inspectors are professionally qualified to a national standard.*

# Study Recommendations:

## Lack of sprinklers

- a) no sprinklers in loading dock, showrooms, or warehouse.
- b) sprinklers inside loading dock controlled fire in less than 1.5 minutes

3) NIST recommends: *All state and local authorities adopt and enforce model code requirements for sprinkler systems*

- a) for all new commercial retail furniture stores regardless of size; and*
- b) for existing retail furniture stores with any single display area of greater than 190 m<sup>2</sup> (2000 ft<sup>2</sup>).*

# Study Recommendations:

## Research Recommendations

- 1) Upholstered Furniture Flame Spread –
  - a) prediction of ignition,
  - b) prediction of fire spread, and
  - c) smoke and toxic gas generation
- 2) Improving Fire Barriers –
  - a) fire spread through walls
  - b) fire spread through doors, glass, wood, & metal
  - c) perf. of roll-up doors in actual fires and extended service
- 3) Decision aids for resource allocation
  - a) computer-aided decision tools
  - b) computer models to assist communities in allocating resources
- 4) Ventilation of Burning Structures
  - a) characterize how vent. affects growth and spread of fire
  - b) provide fire service with guidance on when and how to use ventilation to improve fire conditions
- 5) Performance Metrics for Fire Protection
  - a) performance and effectiveness metrics for community fire protections
  - b) survey effectiveness of existing fire services

# NIST welcomes comments on Draft Report

Web site to view draft final report:

<http://www.nist.gov/el/investigations/bfrr-investigations.cfm>

(All comments received by December 2, 2010 will be considered prior to issuing the NIST Final Report)

Submit comments to:

E-mail: [firesafety@nist.gov](mailto:firesafety@nist.gov)

FAX: [\(301\) 975-4052](tel:(301)975-4052)

Mail address:

NIST Technical Study: Sofa Super Store  
National Institute of Standards and Technology  
100 Bureau Drive, Stop 8660  
Gaithersburg, MD 20899-8660

## Next Steps-

- 1) Consider and incorporate public comments
- 2) NIST will work with model code organizations to incorporate recommendations in national model code
- 3) NIST will work with the major organizations representing state and local governments, including building and fire officials, and fire fighters to incorporate recommendations
- 4) Develop new performance standards and test protocols for fire protection systems
- 5) Conduct additional research in
  - a) Upholstered Furniture Flame Spread –
  - b) Improving Fire Barriers
  - c) Decision aids for resource allocation
  - d) Ventilation of Burning Structures
  - e) Performance Metrics for Fire Protection